THE

AËRONAUTICAL JOURNAL

(FOUNDED 1897 in succession to the ANNUAL REPORTS)

The Organ of the Aëronautical Society of Great Britain

Telephone:
3656 VICTORIA

Telegrams:
"DIDASKALOS, LONDON."

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Published Quarterly

Subscription per Annum, post free, 6s. 6d.

All Communications should be addressed to—
THE EDITORS, 53, Victoria Street, Westminster, London, S.W.

No. 59. JULY, 1911. VOL. XV.

Notices of the Aëronautical Society of Great Britain

GENERAL NOTICES

June Elections: HAROLD BOLAS; JOHN E. HUSON; W. J. MALLINSON; MAJOR A. M. ROGERS.

July Elections: HARRIS BOOTH; GILBERT DENNISON; B. M. JONES; CAPTAIN M. F. SUETER, R.N.; CAPTAIN F. H. SYKES.

¶ The following address, signed by the President of the Society, was forwarded to H.M. the King, through the Lord Chamberlain, on the occasion of His Majesty's Coronation :—

"To the King's Most Excellent Majesty.

"May it please your Majesty

"We, the President, Council and Members of the Aëronautical Society of Great Britain, desire to lay before Your Majesty an expression of our loyal and dutiful attachment and our heartfelt congratulations upon Your Coronation.

"We gratefully recall the occasions upon which Your Majesty has graciously manifested interest in and sympathy with the advancement of aëronautical science and practice in this country, and we fervently pray that Your Majesty and the Queen will be long spared in the reign which has so auspiciously begun."

¶ The following communication and enclosure has been received from Mr. W. R. Turnbull, who represented the Society at the dinner of the Aëronautical Society of America held at New York on April 27 last :—

May 6th, 1911.

THE SECRETARY, AËRONAUTICAL SOCIETY OF GREAT BRITAIN.

DEAR SIR,

I have to report that I attended the First Annual Banquet of the Aëronautical Society of New York as the representative of the Aëronautical Society of Great Britain.

About 100 sat at the tables, and there were many interesting speeches—especially those of President Taft and Admiral Peary. I offered the felicitations of the British Society in a short speech and was most cordially entertained. I enclose Mr. Hill's letter which may be of interest to you and remain,

Sincerely yours,

(Sgd.) W. R. TURNBULL.

(Enclosure) May 2nd, 1911.

W. R. TURNBULL, ESQ., LABORATORY, ROTHESAY, N.B., CANADA.

MY DEAR MR. TURNBULL,

I particularly regret that I was not able to see you again before you left New York on your homeward trip.

The members of the Aëronautical Society have been particularly honoured by your presence as a representative of the great Aëronautical Society of Great Britain. Had you been at a regular meeting of the Society instead of attending one of its public functions I am sure you would appreciate this fact in a way not easily to be forgotten, not that the members are of a demonstrative disposition, but because we have always held in the highest esteem the history and work of your British organisation. I feel that you may not have received sufficient personal attention during your short stay in New York to have you realise all that I am here stating, but I urge upon you the assurance that any oversights of which we have been guilty have been due to the rush and pressure of matters pertaining to the banquet, which you, of course, appreciate was quite an undertaking, especially considering that the undersigned was without any very great experience in matters of this kind. We sincerely hope that in writing to the British Society you will assure them of our kindliest feeling and high esteem and our desire to co-operate with them in every way possible for the advancement of aeronautical science and for general mutual good. To this end the Society will gladly embrace every opportunity of co-operation.

As Chairman of the Banquet Committee and on behalf of the Society, I also want to thank you personally for your address and your very friendly expressions. I am sure the thoughts expressed by you meet with the friendliest response in the hearts of all the members of our Society. Do not believe that I am stretching matters when I say one of the most cherished recollections of the banquet will be the fact that we were able to entertain you as the special representative of the British Society and particularly in view of the fact that you travelled so many miles to be with us as our guest.

Again thanking you,

Sincerely yours,

(Sgd.) THOMAS A. HILL.

¶ The Adjourned Annual General Meeting of the Aëronautical Society was held at the Royal Society of Arts, John Street, Adelphi, on Thursday, June 8, 1911, at 8 p.m. Mr. E. P. Frost, the President of the Society, was in the chair. It was proposed by Mr. R. M. Balston, and seconded by Mr. H. Delacombe, that the 1911 balance sheet be passed, and upon the President putting the motion to the meeting it was carried unanimously.

The Report of the Committee of Enquiry then came up for discussion, and after many had spoken, including Major Baden-Powell, Colonel Capper, Colonel J. D. Fullerton, Colonel F. C. Trollope and Messrs. H. P. Becher, A. E. Berriman, B. G. Cooper, G. L. O. Davidson, H. Delacombe, J. H. Ledeboer, Hon. H. S. Littleton, Mervyn O'Gorman, F. Handley Page, W. F. Reid and B. Woodward, the following resolution was proposed by Mr. Mervyn O'Gorman, seconded by Major Baden-Powell, and carried unanimously :—

" That the principles of the scheme as contained in paragraphs 1, 2, 3 and 4 of the Report of the Committee of Enquiry dated April, 1911, are approved of by this meeting."

The principles referred to in the motion are as follows :—

(1) That it is necessary to the financial welfare of the Society that the Society should attract the support of all those interested in Aeronautics, irrespective of their technical qualifications.

(2) But that it is equally necessary to the standing of the Society as the officially recognised body dealing with the *science* of Aeronautics, that the constitution of the Society should include a technical side, to which none but those qualified in the science of Aeronautics shall be eligible, and admission to which would, therefore, automatically confer a technical status on those elected.

(3) That the Governing Body of the Society shall be elected by a postal ballot taken in accordance with the methods adopted by modern institutions.

(4) That provision should be made for limiting the liabilities of members to amounts that shall be covered by their subscriptions.

The meeting closed without any further business being done, but subsequently the following correspondence passed between the Council and the Committee of Enquiry :—

June 10th, 1911.

To the Secretary, Aëronautical Society of Great Britain.

Dear Sir,

The Committee of Enquiry realise so fully the urgent necessity of taking some definite and concerted action in the interests of the Society that we venture to hope the Council will consider the enclosed report and memorandum (which is drafted in the form of suggested bye-laws for convenience only) at a Council meeting.

If as the result of their deliberation the Council would like to discuss differences of opinion with the Committee of Enquiry, we suggest that a small conference of six, composed of three members of the Council and three members of the Committee, might most expeditiously deal with the matter.

Yours faithfully,

(Sgd.) A. E. Berriman,

For the Committee of Enquiry.

20th June, 1911.

A. E. Berriman, Esq., 44, St. Martin's Lane, W.C.

Dear Sir,

I am instructed by the Council to thank you for the communication dated 10th June, which you have forwarded on behalf of the Committee of Enquiry. The Council will be pleased to meet three members of the Committee of Enquiry, as suggested, to discuss the Report and Memorandum, and have nominated Colonel J. E. Capper, Colonel J. D. Fullerton, and Major Baden-Powell to represent them.

The Council further desire me to convey their thanks to the Committee of Enquiry for the great trouble they have taken in the preparation of their Report.

I shall be glad if you will kindly let me know on what afternoon next week it would be convenient for your representatives to attend.

I am, dear sir,

Yours faithfully,

(Sgd.) T. O'B. Hubbard,

Secretary.

On June 26 the Conference was held at the offices of the Society at which were present Colonel F. C. Trollope, Colonel J. D. Fullerton, Major Baden-Powell, Mr. A. E. Berriman, Mr. Griffith Brewer and Mr. Mervyn O'Gorman. A complete agreement was reached except upon two minor points which were subsequently reduced to one, and it was decided to submit this point to the members at the special general meeting to be called to ratify the new constitution. Notice of this meeting together with the rules as agreed by the Council and Committee will be circulated to members in due course.

COMMITTEE NOTICES

Bird Construction Committee. The first report of this Committee has now been published and circulated to all members.

Laboratory Committee. The Committee tender their thanks to Messrs. W. N. Brunton and Son for specimens received for testing.

LIBRARY NOTICE

The Council desire to thank the Hon. H. S. Littleton for a framed coloured print of "The Ariel."

MECHANICAL PRINCIPLES OF THE HELICOPTER

BY HERBERT CHATLEY, B.SC.

Professor of Civil Engineering, Imperial Engineering College, Tâng Shan

In spite of the rapid development of aeroplanes there are many experimenters interested in the helicopter; it will perhaps be useful to consider a few theoretical points in connection with this type of machine upon which recent research has thrown a stronger light.

Propeller Thrust with Full Slip.—The principal question that concerns us is the possible value of the propeller thrust, and it should at once be noted that it is probable that much larger values are obtainable for this than is possible in the case of the propellers of an aeroplane. Each horse-power employed by the propeller produces 550 ft.-lbs. of work per second. If, as in the case of the aeroplane, the propeller advances with velocity V (feet per second), the maximum possible thrust in lbs. per HP is

$$T = \frac{550}{V} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

[It should be noted that this disposes of some of the absurdly high claims made by inventors of propellers *for aeroplanes.*]

This formula would give the relation between thrust and horse-power if the propeller were a screw working in a frictionless nut and advancing with velocity V; unfortunately however, a propeller moving in this way in air would encounter no resistance from the air and no thrust would be produced. In the case of a helicopter just suspended, it is obvious that work has to be done in rotating the propeller in order to obtain support from the air, and the value of V defined by equation 1 will be called the velocity of *slip.* Let us consider what is the maximum thrust per HP for a given propeller and motor when the propeller has no speed of advance (*i.e.* 100% slip.)

Plane Blades:—We will call A the area of the blade, r its effective radius or mean distance from the axis, n the number of revolutions per second and β the angle of attack (pitch angle).

The lift (propeller thrust), assuming the "sine" law of resistance, is

$$T = C c \rho A (2\pi r n)^2 \sin\beta \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

where C is a constant (about 0.7), c is the aspect-ratio coefficient (about 3.0) and ρ is the mass per unit volume of air (Lanchester's notation).

The torque to be overcome is

$$M = r[C c \rho A (2\pi r n)^2 \sin^2\beta + \zeta C \rho A (2\pi r n)^2] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

where ξ is Lanchester's coefficient of skin-friction and the work done is

$$[C c \rho A \sin^2 \ + \xi C \rho A] 8\pi^3 r^3 n^3 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

If we assume for example the characteristic curve of the motor, representing the relation between horse-power and angular velocity, to be a curve of sines, we have

$$H = H_0 \sin\left(\frac{2\pi n}{n_0}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

where H_0 is the maximum horse-power and n_0 the number of revolutions the engine would acquire when running unloaded. When the motor and propeller powers are balanced this assumption gives

$$[C c \rho A \sin^2\beta + \xi C \rho A] 8\pi^3 r^3 n^3 = 550\, H_0 \sin\left(\frac{2\pi n}{n_0}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

We can show this graphically by plotting the left hand and right hand term as functions of n. The point where they intersect gives n_1, the speed at which the motor-propeller set will run.*

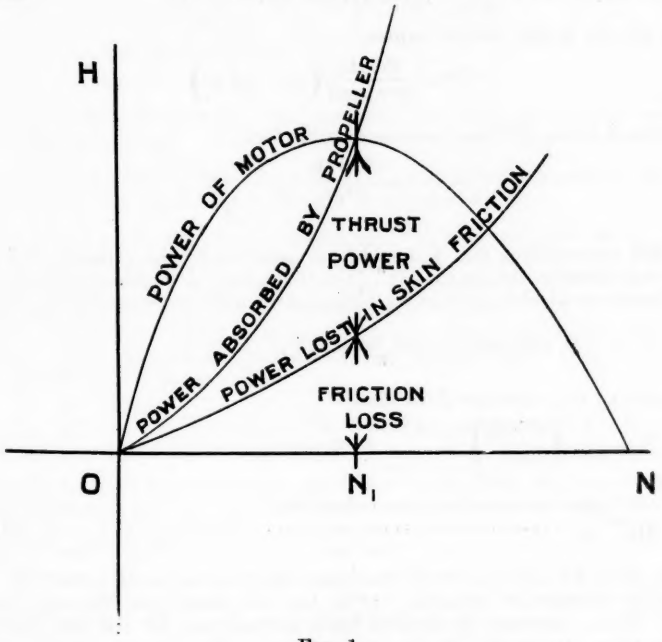


FIG. 1.

In order that the maximum thrust power should be obtained, n_1 should correspond to the abscissa value of the crest of the H curve so that the right hand term becomes 550 H_0, and then the thrust power is

$$\frac{c\sin^2\beta}{c\sin^2\beta+\xi} \cdot 550\,H_0 \text{ ft.-lbs. per sec.} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

and the thrust is

$$C\rho A\sin\beta \,.\, (2\pi r n_1)^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

or in terms of H_0 and n,

$$T = \frac{1}{\sin\beta}\left\{\frac{550\,H_0 - \xi C\rho A.8\pi^3 r^3 n_1{}^3}{2\pi r n_1}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

(6) can be written for this purpose as

$$C\rho A.8\pi^3 r^3 n_1{}^3[c\sin^2\beta+\xi] = 550\,H_0$$

whence

$$A = \frac{550\,H_0}{C\rho.8\pi^3 r^3 n_1{}^3[c\sin^2\beta+\xi]} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

As an example let us consider the following case:
Given $\beta = 5^0$, ($\sin\beta = .09$ nearly), $H_0 = 50$ at $n_1 = 1000$ per min. (= say, 16 per second), $\xi = .02$, $C = 0.7$, $\rho = 0.08 \div 32.2$, $r = 3.5$ ft.

* The power employed for producing a thrust is $\frac{C\rho A\sin^2\beta}{C\rho A\sin^2\beta+\xi C\rho A} = \frac{c\sin^2\beta}{c\sin^2\beta+\xi}$ of the total power employed.

From (10) it is found that A = 8.193 square feet, and the corresponding calculated values of T are: T = 476.2 (by substituting this value of A in (9)); T = 477.1 (by direct application of (8)) the thrust thus being about $9\frac{1}{2}$ lbs. per HP.

The rule for T may also be written

$$T = \frac{550\,H_0}{2\pi r n_1 \sin\beta}\left(1 - \frac{\xi}{c\beta^2+\xi}\right)$$

Putting B for sin B, T may be reduced to the form

$$T = \frac{550\,H_0}{2\pi r n_1}\quad \frac{1}{\beta + \frac{\xi}{c\beta}}$$

To find the condition that T should be a maximum by the variation of β we notice that the denominator contains the sum of two terms β and $\xi/c\beta$ whose product is constant, and by elementary algebra this sum is a minimum when the terms are equal, giving $c\beta^2 = \xi$ and $\beta^2 = \frac{\xi}{c} = \frac{\cdot 02}{3} = \cdot 006$ and $\beta = \cdot 081$ (nearly 5°)*

Employing this value for β we have

$$T = \frac{1}{\cdot 081}\left(\frac{275\,H_0}{2\pi r n_1}\right)$$

or,

$$\frac{T}{H_0} = \frac{540}{r n_1} \qquad \ldots\ldots(11)$$

Thus, if r is 3·5 and n_1 is 16, the maximum thrust in lbs. per HP is 9·647 lbs. This can obviously be increased by reducing r or n_1, but this means that the area must be increased. With a constant HP the area varies inversely as $r^3 n^3$, and will rapidly become excessive unless superposed blades are employed. The formula would indicate that numerous slow-running small-diameter propellers are best for helicopter purposes. The question of interference and sufficient air supply will also be very important if large areas are used. Slow-running motors are heavier than rapid ones, but this difficulty can be overcome by using reducing gear.

If $r = 2{\cdot}0$ and $n_1 = 10$, then $\frac{T}{H} = 27$ lbs., and A = 180·3 sq. ft. for 50 HP or 3·6 ft. per HP.

If we say that A shall bear a certain ratio to r, it will perhaps be possible to find a rough limit for $\frac{T}{H}$. If A was a complete disc area, then it would be πR^2, where R is the radius of the disc, or if we assume $r = \frac{3}{3}R$, $A = \frac{9\pi}{4}r^2$. It is not, however, possible to use a whole disc area without causing interference. Let us assume A can be made equal to $3r^2$. So that area per HP is $\frac{3r^2}{H}$. Inserting this value in the formula for A we get

$$\frac{3r^2}{H} = \frac{550}{C\rho.8\pi^2 r^3 n_1{}^3[c\sin^2\beta+\xi]}$$

Solving for n_1, we have

$$n_1{}^3 = \frac{10620\,H}{r^5} \qquad \ldots\ldots(12)$$

* A similar result has been obtained by Lanchester for the aeroplane, but in a slightly different way.

Thus a 50 HP motor, when the effective radius of the propeller is 3·5 ft., should run at a speed

$$n_1 = \sqrt[3]{\left(\frac{10620 \times 50}{3{\cdot}5^5}\right)} = 10{\cdot}02 \text{ r.p. sec.}$$

and A = 36·76 sq. ft.

and T = 15·4 lbs. per HP.

But formula (8) gives 15·03 lbs. The discrepancy is due to the degree of approximation used in the calculations.

By reducing r a further increase might be obtainable, but almost certainly the limiting thrust is about 20 lbs. per HP for practicable arrangements.

Curved Blades :—All the above remarks apply to plane surfaces (or simple helical ones) and we will next consider the effect of employing an aerocurve section for the blades. By using a curve to which the stream-line flow accommodates itself the aerodynamic resistance may be greatly increased. The frictional resistance is probably not much affected or is, if anything, slightly increased, since both sides of the blade are more subject to its action. In the case of the plane surface the maximum ratio of the thrust to the resistance (Turnbull's "efficiency") is

$$\frac{c\beta}{(c\beta^2 + \xi)} = \frac{3 \times 0{\cdot}08}{(3 \times {\cdot}006) + {\cdot}02} = 6 \text{ approximately.}*$$

Supposing we have a simple concave surface making a front angle α and a rear angle β with the direction of motion, then when there is *discontinuous* motion, approximately †

$$T = C c\rho A(2\pi r n_1)^2(\alpha + \beta) \quad \ldots\ldots\ldots\

It will not in general be convenient to make α or β constant, a constant *ratio* between them being usual. Let $\beta = n\alpha$ then

$$\frac{T}{R} = \frac{c\left(\frac{\beta}{n^2}+\beta\right)}{\frac{c}{2}\left(\beta^2-\frac{\beta^2}{n^2}\right)+\xi} = \frac{2\left(1+\frac{1}{n}\right)}{\beta\left(1-\frac{1}{n^2}\right)+\frac{2\xi}{\beta c}}$$

the denominator of which is a minimum when

$$\beta\left(1-\frac{1}{n^2}\right) = \frac{2\xi}{\beta c} \quad \text{or} \quad \beta = \left(\frac{2\xi n^2}{c(n^2-1)}\right)^{\frac{1}{2}}$$

Thus if $n = 2$ (see below) we have

$$\beta = \sqrt{\left(\frac{2\times\cdot02}{3\times\cdot75}\right)} = \cdot13$$

For this value of β, $\frac{T}{R} = 15$ exactly, which would appear to be the maximum value for this ratio of the angles ($2\alpha = \beta$). Phillips obtained experimentally a ratio of 20 : 1 for his best form of aerocurve. By slightly altering n, the value may perhaps be improved, but it must also be borne in mind that the flow in front of the curve must be as nearly of the stream-line type as possible. This result seems to be best obtained by the use of $n = 2$.

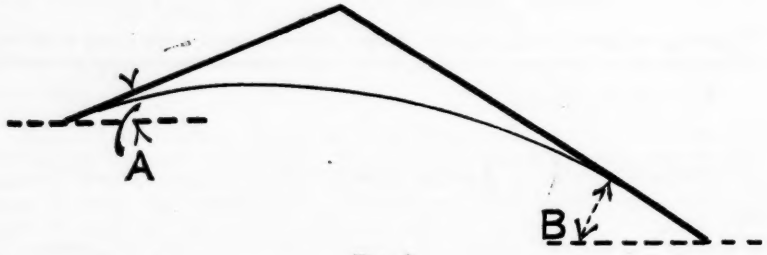


FIG. 2

In order that the reaction shall be continuously positive (it may become negative if the front or dipping edge of the curve is depressed a little below the level of the trailing edge) it is usual to make the chord of the curve present a definite angle to the direction of motion. Many experimenters, *e.g.*, Ferber, Lilienthal, have expressed the reactions in terms of this angle, but since this involves a separation specification of the action of the curve, this method is undesirable. Hence, to avoid the curvature at the dipping edge from being very sharp, α is generally made less than β. $\frac{1}{2}\beta$ is a common value. Employing this value, the following ratios for $\frac{T}{R}$ are obtained as functions of β.

β radians	$\frac{T}{R}$	β radians	$\frac{T}{R}$	β radians	$\frac{T}{R}$
·01	2·2	·05	9·8	·15	14·8
·02	4·4	·075	12·8	·20	13·8
·03	6·4	·1	14·4	·25	16·0

Note.—·20 radians equal 11·4°

The first maximum value is thus at about ·13 radians = 7·6°.

Reverting to formula (9) for the plane surface, we see that the thrust for a concave surface is

$$T = \frac{\cdot 2}{(\beta - a)} \frac{550\, H_0}{2\pi r n_1} \left(1 - \frac{\xi}{\frac{1}{2}c(\beta^2 - a^2) + \xi}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (16)$$

Assuming $a = \frac{\beta}{2}$ and disregarding constant terms, we have

$$T a \frac{1}{\beta} \left[1 - \frac{\xi}{\frac{3}{8}c\beta^2 + \xi}\right] \quad \text{or} \quad \frac{1}{\beta + \frac{8\xi}{3c\beta}}$$

the denominator of which is a minimum if $\beta = \frac{8\xi}{3c\beta}$ or

$$\beta^2 = \frac{8\xi}{3c} = \frac{\cdot 16}{9} = \cdot 018$$

$$\beta = \sqrt{\cdot 018} = \cdot 134 = 7\tfrac{2}{3}^\circ$$

$$\text{and } a = \cdot 067 = 3\tfrac{5}{6}^\circ$$

Inserting these values in (16) we have

$$T = \frac{2}{\cdot 067} \left(\frac{550\, H_0}{2\pi r n} \left[1 - \frac{\cdot 02}{(1{\cdot}5 \times 0{\cdot}75 \times \cdot 134^2) + \cdot 02}\right]\right)$$

The expression within the brackets in the numerator is the mechanical efficiency and is almost exactly 50 %, so that we can write

$$T = \frac{2}{\cdot 067} \left(\frac{275\, H_0}{2\pi r n_1}\right)$$

whence

$$\frac{T}{H_0} = \frac{1306}{r n_1}$$

Reverting to our original example where $r = 3{\cdot}5$ and $n_1 = 16$, this gives a thrust of 23·32 lbs. per HP. The same reasoning as before will apply to the question of reducing r and n_1, and so increasing the thrust. The maximum practicable amount would appear to be about 30 lbs. per HP, considerably less than is obtainable with the aeroplane.

The area is deducible from the resistance equation (14).

$$A = \frac{500\, H_0}{c\rho 8\pi^3 r^3 n_1^3 [\frac{1}{2}c(\beta^2 - a^2) + \xi]}$$

and is about 9 sq. ft. for the given example.

It will be noticed that owing to the use of a greater angle of attack the resistance of the aerocurve is much the same as that of the aeroplane, but the lift (thrust) is greater, and we should therefore expect maximum efficiency to occur for about the same angle as maximum lift-to-drift ratio. A comparison of the value of β obtained from formula (16) with the best lift-to-drift value in the table preceding the formula shows that this is the case. This increase of lift for the same resistance is the particular virtue of the aerocurve and explains its general use.

From the above data it is possible to design with a fair degree of accuracy propellers to give a thrust of from 10 to 25 lbs. per HP with a given speed, and it will be our next business to consider the other parts of the machine.

Car : The weight limit will prevent a great upward acceleration from being attained, so that while it is preferable to form the vertical section of a stream-line type, more particular attention must be given to the longitudinal sections of the car. The few successful helicopter machines have generally had so little weight to spare that open frames have been used, but any large machine must certainly have a covering over the car frame to decrease resistance. The fish shapes employed for dirigible balloons naturally suggest themselves, although a flat-bottomed form such as I suggested in 1907 (" Problem of Flight ") would be convenient for landing purposes, although of slightly higher resistance to propulsion.

Allowing 25 lbs. thrust per HP for the lifting propellers and 5 lbs. per HP for the weight of machinery and propellers, we have 20 lbs. per HP remaining. If one passenger and an equal weight in fuel be allowed (say 350 lbs.) we have a balance of 650 lbs. in the case of a 50 HP motor for propulsion, mechanism, car and any additional load. The framing could be much smaller than that necessary for an aeroplane so that, including an allowance for rather complex framing for the support of say four vertical propeller shafts and a general sheeting, 300 lbs. in this respect would probably suffice, leaving 350 lbs. for propulsive mechanism.

Propulsive Mechanism : The power required for propulsion is a somewhat uncertain quantity since, if the lifting propellers are exposed to the relative wind due to translation, they will experience considerable resistance on the side when the blades are travelling in the same direction as the machine. This effect will somewhat enhance the lifting-force, but the increase of resistance will decrease the speed of rotation and so decrease the HP supplied by the motor by an almost indeterminate amount. Forward inclination of the axis of the lifting propellers so as to obtain propulsion seems of doubtful utility, unless the lifting propellers are screwed so as to avoid this resistance. On the whole the use of large casings or shafts for the propellers seems preferable, combined with a low-powered propelling screw. The resistance of the machine in this way could be reduced to quite a small amount and the only serious question is the adequacy of the feed to the lifting propellers and the friction in the shafts surrounding them.

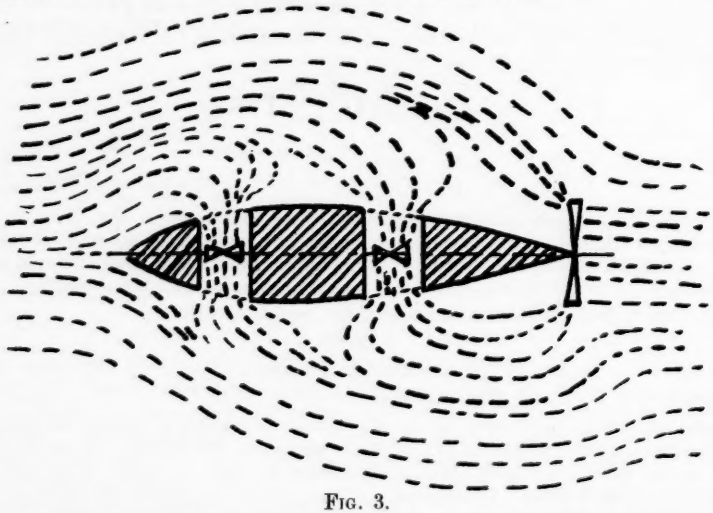


FIG. 3.

It is of course impossible to say exactly how the air will flow about such a contrivance, but the sketch shows the system which seems probable. There can be little doubt that a portion of the work done by the propelling screw will simply serve to feed the lifting screws and for this reason more power will be required than is necessary to overcome the simple resistance of the car. How much, is a matter of experiment. The thrust on the propelling screw will probably not be symmetric, since the lower field will either be negative (due to the discharge from the lifting screws sweeping below it) or excessive (due to the discharge from the lifting screws feeding it). What turning movements this may produce is doubtful, but that a torque will appear seems certain.

Stability : Apart from variations of the aerodynamic conditions (not predictable at present) the machine will be in a state of neutral equilibrium since all the steady thrusts are equilibriated about the centre of gravity. A gust will therefore have a serious disturbing effect and probably gyrostatic control or auxiliary aeroplanes will be necessary to stabilise it.

The only apparent advantage then of this type of machine is its ability to move slowly. From the point of view of mechanical efficiency it is certainly deficient.

SKIN FRICTION

BY W. ELLIS WILLIAMS

Among the various experimental data which are required in the discussion of the theory and design of the aeroplane, there are none of greater importance than those relating to surface friction, while at the same time there are none about which greater uncertainty prevails.

Owing to the difficulty of separating skin friction from head resistance, very little can be learnt from observations on actual machines in flight, while on the other hand, if we turn to laboratory experiments on the resistance of planes, we are met with the most bewildering variations in the values obtained for it. Many of the most careful experimenters make out that it is quite inappreciable while others maintain that it is from 1—4 per cent. of the normal pressure, and therefore forms an important part of the drift at small angles of attack. Under these circumstances perhaps the following theoretical considerations may not be without interest, and may serve to throw some light on the question.

The total reaction between a fluid and any point of a solid which is immersed in it may be divided into two parts, the first is perpendicular to the surface of the solid and equal to the pressure in the fluid near the point, the second part is parallel to the surface of the solid and is what we refer to as " skin " or " surface " friction, it vanishes when the solid is at rest relative to the surrounding fluid, and in other cases is proportional to the rate of change of velocity of the fluid at the surface of the solid, this rate of change being measured perpendicular to the surface.

If for any particular solid the shape of the stream lines remained the same for different velocities, then the rate of change of velocity, and consequently the force of skin friction, would be proportional to the velocity. The analysis of viscous motion given by Stokes shows that this is the case if the velocity is so slow that the inertia of the fluid may be neglected, and for these velocities the surface friction varies directly as the velocity. When, however, the velocity is increased beyond a certain limit, depending on the coefficient of viscosity of the fluid, the form of the motion begins to change and the proportion between force and velocity ceases. As the velocity is increased the influence of viscosity as compared to the inertia diminishes still further, and the motion again begins to approximate to a fixed form, independent of the velocity. It can in fact be shown that the rotational velocity to which viscosity gives rise is propagated from the surface of the solid according to the same laws as the conduction of heat, and for high velocities the rotation is therefore confined to the layers of fluid which have passed close to the boundary of the solid, and the greater the velocity the narrower the range of its influence. Finally at high velocities the general form of the motion becomes independent of the velocity, as is shewn by the normal pressures becoming proportional to the square of the velocity. The tangential force, however, depends on the motion of the fluid in immediate contact with the solid, and this motion is still variable, changing its form with the velocity, however high it may be. It follows, therefore, that while the normal pressures vary with the square of the velocity, and are therefore independent of the surface experimented upon, the skin friction will vary with the velocity and size of plate in a way which cannot be determined except by experiment, or by a complete solution of the equations of motion.

We may now proceed to consider the results of the various experiments which have been made to determine the skin friction on thin plates moving parallel to their own planes, and to compare them in the light of the considerations developed above. The results must first be reduced to dynamically similar forms of motion, which can be done by a method first indicated by Helmholtz which may be thus stated :—If in any two experiments on geometrically similar bodies moving in the same fluid the velocities be V_1 and V_2 and the dimensions l_1 and l_2, then if $V_1 l_1 = V_2 l_2$ the motion of the fluid will be similar in the two cases and the forces on corresponding similar portions of the surfaces will be the same, or, the forces on unit area will be as V_1^2 to V_2^2. In comparing the results

of different experiments we must therefore take account of the product Vl, and we can only apply the results of experiments to cases in which this product has the same value. Now in laboratory experiments l the dimension of the plate experimented upon is much smaller than the wings of an actual machine, and V is at best of equal value, hence the results of experiments in the laboratory, even if themselves free from error, must be used with great caution in calculations referring to actual aeroplanes.

In the following table the results of all available experiments on surface friction have been collected together, the value of Vl being shown in each case.

The results are necessarily somewhat vague, as different observers have employed different methods and different shapes of plates. The result given as Langley's has been calculated from the curve on p. 64 of his book.* Langley himself thought the surface friction negligible, but the value given agrees better with his observations.

	Vl in feet sec.	Friction in %	Method.
Lilienthal ..	30	6·8	Whirling table
Langley ..	30	1·0	,, ,,
Turnbull ..	10	4	Wind tunnel
Riabouschinsky		1	,, ,,
Maxim.. ..	36	0	,, ,,
Lanchester ..	20	1·5	,, ,,
Prandtl ..	26—44	1	,, ,,
Rateau ..	30—140	0	,, ,,
Zahm	12	·8	,, ,,
,, ...	32	·67	,, ,,
Williams ..	3	3	Pendulum

The friction is given as a percentage of the total force for normal incidence, and should be the same for the same value of Vl. The results given in the above table are plotted out in Fig. 1 and it will be seen that though the points are somewhat widely

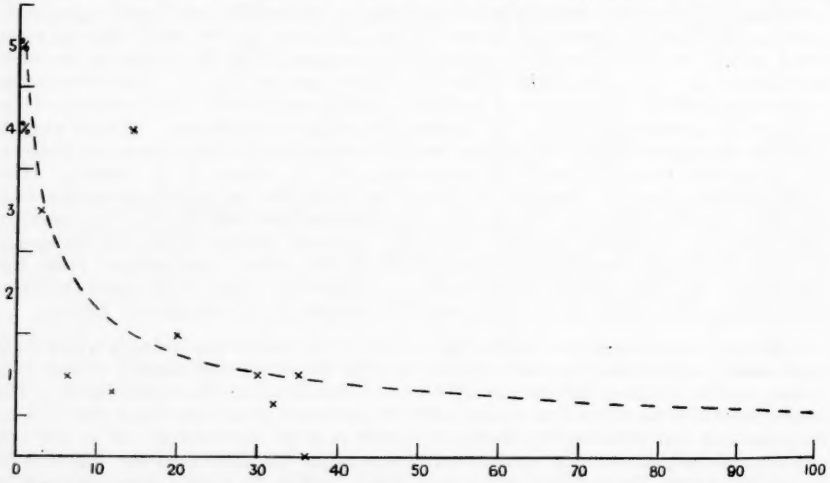


FIG. 1.—FRICTION AS % OF NORMAL FORCE FOR DIFFERENT VALUES OF Vl. (Vl in feet sec.)

* *Experiments in Aeronautics*, Washington (D.C.): Smithsonian Institute, 1891.

scattered, yet they show a rapid diminution of friction with increase of Vl. This means that for a plate of given size the skin friction increases at a slower rate than V^2.

When the motion of the fluid is regular, an approximate solution of the equations of motion shows that the friction increases as $V^{3\cdot2}$. The chief steps of this approximation are as follows :—At high velocities the motion of the fluid is confined to the layers close to the plate, the velocity diminishing rapidly with distance from the plate, hence the rate of change of velocity parallel to the plate is small compared to the rate of change of velocity perpendicular to the plate, the form of the stream lines being something like Fig. 2.

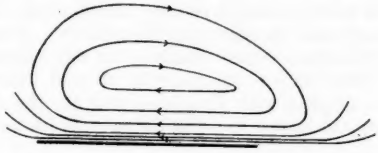


FIG. 2.—SKETCH OF STREAM LINES AROUND PLATE

Taking this into account the equations of motion reduce to

$$\nu \frac{d^3v}{dy^3} = \frac{v\,d^2v}{dxdy} + \frac{u\,d^2v}{dy^2}$$

v being the velocity parallel and u the velocity perpendicular to the plate, ν is the kinematic coefficient of viscosity of the fluid. To solve this equation we assume that v is given by an expression of the form,

$$v = \mathrm{V} - \mathrm{V}e^{f(x)y}$$

V being the general velocity of the fluid relative to the plate, and $f(x)$ an undetermined function of x.

Differentiating this, and substituting in the equation of motion we can find the value of $f(x)$ to give the best approximation. The equation for $f(x)$ is

$$-\nu f(x)^3 = Uf(x)$$

whence

$$f(x) = -\frac{1}{\sqrt{2}} \frac{V^{\frac{1}{2}}}{\nu^{\frac{1}{2}}x^{\frac{1}{2}}}$$

and

$$\frac{du}{dy} = V f(x) = -\frac{1}{\sqrt{2}} \frac{V^{3\cdot2}}{v^{\frac{1}{2}}x^{\frac{1}{2}}}$$

and the force per unit area is $\sqrt{2}\,\rho\,\nu^{\frac{1}{2}}V^{3\cdot2}l^{-\frac{1}{2}}$, where l is the length of the plate in the direction of motion, the other dimension being supposed very great compared with l. Substituting for ν its value (= ·132) we get for the surface friction in air,

$$\mathrm{F} = 1{\cdot}02\,\rho\mathrm{V}^{3/2}l^{-\frac{1}{2}} \text{ per unit area (c.g.s.) of double surface.}$$

Now the normal force is $\mathrm{F} = {\cdot}59\,\rho\mathrm{V}^2$, and the ratio of skin friction to normal force is therefore

$$1{\cdot}73\,/\,(Vl)^{\frac{1}{2}}$$

The values of this expression are shown by the dotted line in Fig. 1, and it will be noticed that it lies well within the range of the experimental results. The assumption made in finding the formula render it inapplicable to low velocities ; at these velocities it must gradually alter into Stokes' law, which applies to very low velocities, giving frictional force proportional to the velocity.

A different consideration shows that there must also be an upper limit to the range of its applicability. At very high velocities the regular stream line motion becomes unstable and gives place to a turbulent motion which will give a different law for the surface friction. In Osborne Reynold's pipe experiments the regular motion broke down when the mean

velocity exceeded 1,000 V/a, a being the radius of the pipe. If the breakdown occurs similarly in the motion around a plate, we may put a equal to the thickness of the fluid layer moving with the plate. A value for this may be deduced from the above formula for the velocity. Thus, if V is 1,000 cms. and l 30 cms., then the velocity falls to a fifth of its value in 1·5 mm., and this may be taken as the thickness of the layer. At the point where the motion breaks down we have $Va = 1{,}000\ \nu = 132$ for air. Thus if V = 1,000, the motion will break down when $l = 39$ cms. So that in air the turbulent motion is set up when $Vl = 3{,}900$ cms. sec. or 42·4 feet sec.

For water ν is ·017, and the critical value of Vl is 5.45 feet sec. For velocities higher than the critical value the friction must be nearly independent of the length of the plate. and consequently must vary with the square of the velocity. The ratio of surface friction to normal pressure will therefore remain constant at the value to which it had fallen at the critical velocity. This value is the same for air and water, and is approximately ·9 per cent., which agrees roughly with Froude's value for the surface friction of plates in water. In Fig. 3 curves are drawn showing the ratio of friction to normal pressure for

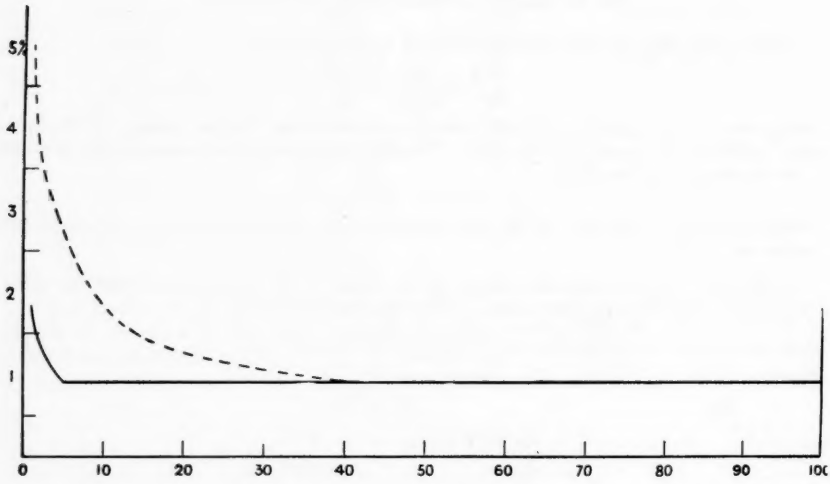


FIG. 3.—SURFACE FRICTION FOR AIR AND WATER (CALCULATED) AIR – – – –, WATER ———— (Vl in feet sec.)

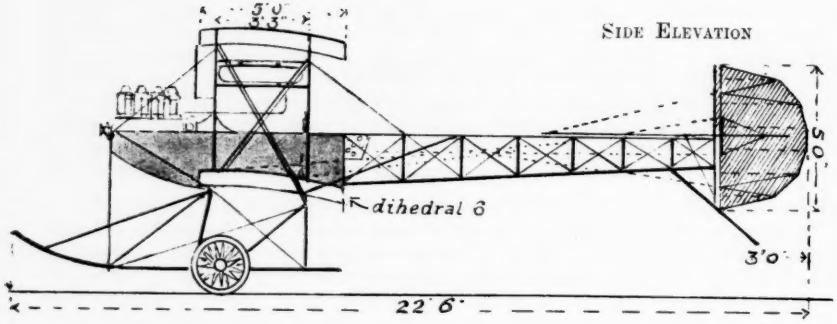
both air and water. Starting from infinity at zero velocity, the ratio falls rapidly until the critical velocity is reached and then remains constant however high a value the velocity may attain.

So far, therefore, as our somewhat uncertain theory may enable us to predict, the skin friction in an actual aeroplane will be of the order of 1 per cent. of the force at normal incidence.

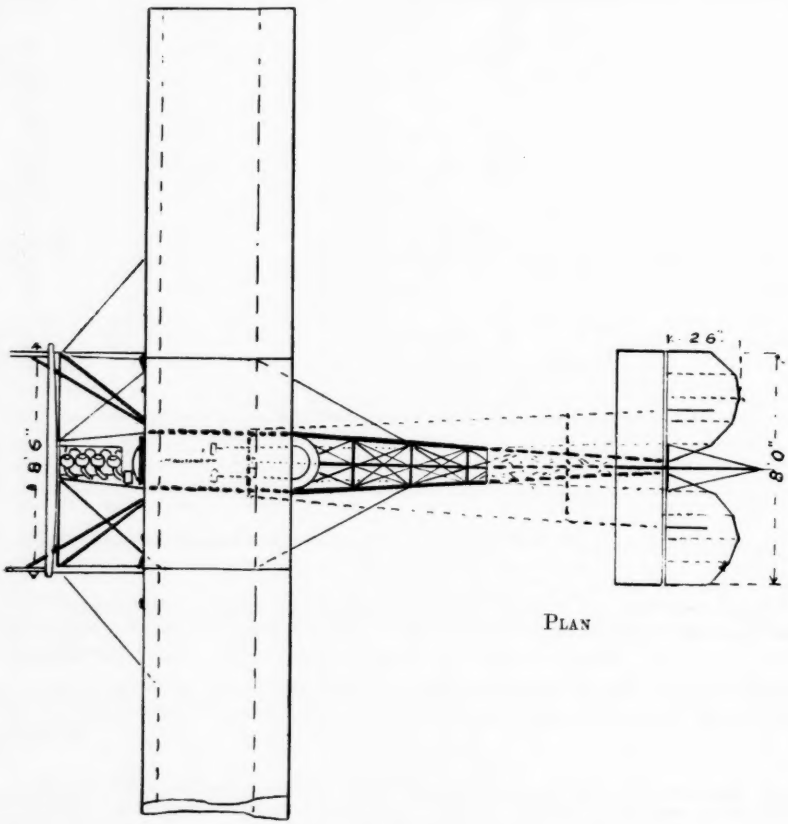
NOTE.—Since writing the above Lord Rayleigh has published (Philosophical Magazine. June, 1911), a formula for the surface friction which is practically the same as the one given above, differing only in the constant, with the same notation as above it gives:

$$F = \frac{2\rho\, \nu^{\frac{1}{2}} V^{3/2} l^{-\frac{1}{2}}}{\pi^{\frac{1}{2}}}$$

The formula is deduced by an extension of Stokes' result for an infinite plane, and is subject to the same limitations as the one given in the text.—W. E. W.



SIDE ELEVATION



PLAN

THE ROE BIPLANE

MEMBERS' MACHINES: No. 5

THE ROE BIPLANE

THE name of Mr. A. V. Roe has been familar to all students of British aeronautics since the dawn of practical flight as a patient and persevering worker in the face of great difficulties. For several years past he has been flying in his triplanes, and his latest machine, a biplane, is one of the most speedy of its class.

The chief dimensions of the machine, which is illustrated in the accompanying drawings, are as follows: Main planes (which are set at a slight dihedral angle): span, upper plane 33 feet, lower plane 23 feet; chord, 5 feet; gap, 5 feet; area, 280 sq. feet. The over-all length of the body is 22 feet 6 inches, and the distance between the trailing edge of the main planes and the forward edge of the tail is 14 feet.

The horizontal tail, 8 feet span and 2 feet chord, is flat with a rigid forward and trailing edge, over which fabric is loosely stretched so as to assume a natural curve in flight.

The controls are operated by a wheel and foot-rest controls are fitted. The former by a to-and-fro motion operates the elevator-flaps, each of 2 feet span hinged to the trailing edge of the horizontal tail, and warps the main planes by a lateral movement. The vertical rudder, 5 feet by 3 feet, is controlled by the foot-rest.

A special feature of the machine lies in the fact that both the main planes, which have a camber of 2½ inches throughout, are built up in 5-foot sections, except the centre section which is 3 ft. in each plane, so that in case of breakage a section can be quickly removed and another fitted.

The materials used are ash, hickory and elm—the body being entirely built up of spruce—and the fabric is Pegamoid.

The motor is a 30 HP. Green, driving an 8 ft. 6 in. "Avro" propeller, and the radiator is carried over the top plane, lying flat in the middle. The fore-end of the body and the cock-pit are covered in with aluminium sheeting. The chassis is an adapted Farman type, a combination of wheels and skids, with the skids carried well up forward. The total weight of the machine, without the pilot or petrol, is about 550 lbs., and its mean speed is about 45—50 miles per hour.

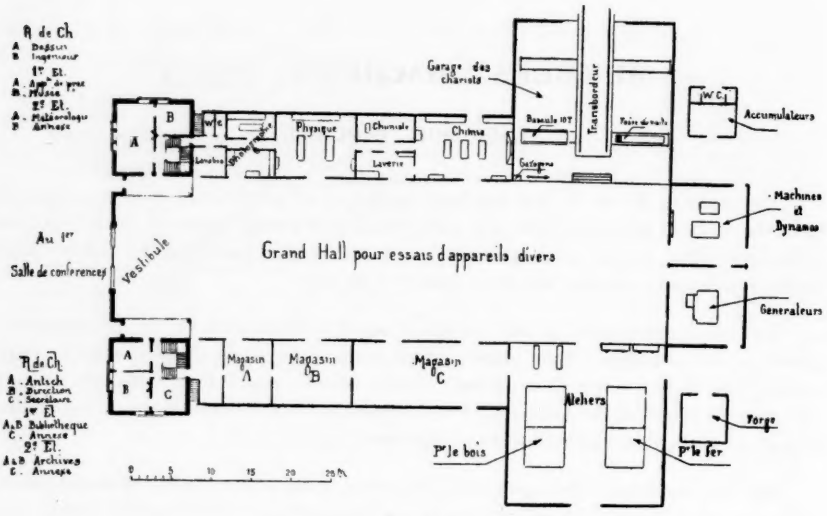


FIG. 1

GROUND PLAN OF AEROTECHNICAL INSTITUTE

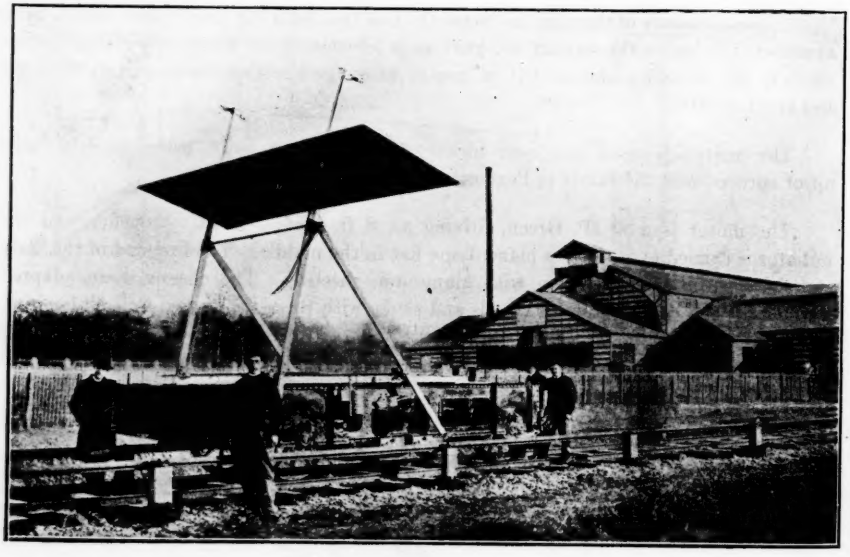


FIG. 2

ROLLING CARRIAGE WITH PLANE MOUNTED FOR TEST

(Main Buildings in background.)

AEROTECHNICAL INSTITUTE OF THE UNIVERSITY OF PARIS

FOUNDED by the generosity of M. Henry Deutsch de la Meurthe, the Aerotechnical Institute of the University of Paris was inaugurated at St. Cyr on July 6th last. Its object is entirely scientific and is to study all theoretical and practical problems of aviation and aerostation relative to the support of bodies in the air, both at rest and in motion. Under the Presidency of the Vice-Rector of the Paris University with M. Deutsch de la Meurthe and the Dean of the Faculty of Sciences of the Paris University as Vice-Presidents, the Council includes all the famous names in French aeronautics as follows:—MM. Armengaud, Léon Barthou, Baumès, Blériot, Bouttieaux, Cailletet, Carpentier, Eiffel, Estienne, Hugon, Janet, Jouquet, Henry Kapferer, Koenigs, Le Cornu, Loreau, Maurain, Marchis, Painlevé, Picard, Sauvage, Soreau, Surcouf, Urbain, Gabriel Voisin and Weiss. The direct management is in the capable hands of M. Maurain, with M. Toussaint as Chief Engineer and M. Payeu as Secretary-Accountant.

The area occupied by the buildings and grounds is 72,000 square metres, of which the principal part has been reserved for building purposes. The remainder includes a strip 25 metres by 900 metres, with an additional piece of some 462 metres in length which has been conceded by the Minister of War. Moreover, 4,000 metres have been set apart for the erection of aeroplane sheds, workmen's houses, &c.

The general arrangement of the main buildings is shown in the accompanying plan.

In the Central Hall are the following:—

(1) A large fan two metres in diameter fitted with various adjustments and an aerodynamical balance for measuring wind pressures on surfaces.

(2) A wind tunnel furnished with a fan for the study of the reaction of the air on surfaces, the air-circuit being capable of maintaining a uniform speed of 20 metres a second.

(3) An aerodynamical balance.

(4) A wind tunnel similar to that built by Colonel Renard for studying the stability of model hulls or planes.

(5) An apparatus for measuring the friction of various surfaces moving through air at gradually increasing speeds.

(6) A dynamometrical installation for measuring the thrust of stationary propellers.

(7) An installation for the study of helicopters.

(8) A protected chamber for testing the resistance of propellers at very high speeds. (Although it would be difficult to attain to bursting speed, it will be possible to run them at a considerably higher rate of revolution than the normal).

(9) A test bench for motors.

In the chemical laboratories researches will be made in the study of light gases, of fabrics for balloon envelopes and aeroplane coverings, and of varnishes.

The physical laboratories will be concerned with the improvement and application of instruments used in aerial navigation, and the physical properties of light gases.

The photographical section will be occupied in obtaining records of experiments made; a special department will test all materials used in the construction of flying-machines and dirigibles; and the usual meteorological instruments are provided.

The power-house contains two compound vertical steam-engines one of 120—150 HP. and the other of 30—40 HP. driving dynamos of 200—300 ampères and 160 ampères respectively.

In the grounds is an experimental track 1,400 metres long, quite straight and perfectly flat save for 80 metres at one end, which has a slope of 10 mm. in the metre to facilitate the start of the rolling platforms, and a rise of 5 mm. in the metre at the other end to assist stopping and returning them.

The rails are 12 metres in length welded two together by an aluminothermal process so as to give 24 metres without a joint. The current is conveyed to the carriage by live rails raised on oak standards about 0·7 metre in height on each side of the track, the return being made through the track-rails themselves.

Four rolling platforms are to be provided, each designed and fitted for its special work. The first measures the vertical and horizontal components of air-pressure on planes and curves both simple and compound, and determines the position of the centre of pressure at various angles of incidence. This has been already built. The others under construction are to comprise two for propeller testing (one for large dirigible propellers and the other for aeroplane propellers to obtain their thrust, speed of rotation, the power absorbed, and their mechanical efficiency) and one for measuring the resistance of the different parts.

Platform No. 1, here illustrated, weighs, including the motor of 1,100 kgs., 4,900 kgs. The iron chassis is 6·12 metres long and 2 metres wide and is rounded in front. The motor-bed is carried in the centre. Two axles 3·60 m. apart carry the chassis, which projects 1·86 m. in front and 0·66 m. in rear. This inequality is for the purpose of putting additional weight on the front axle which tends to be lifted during experiments with large horizontal surfaces. For the same reason the axis of the motor is nearer the front axle than the back axle. The wheels of cast steel are one metre in diameter. The steering swivels run in ball-bearings and special arrangements are used to prevent lateral play. A system of brakes engaging additional rails at the end of the track brings the platform to a standstill. All the platforms are to be fitted with the following instruments :—

(1) A registering chronograph for the number of turns of the axles.

(2) A registering cinemometer giving the speed at every point along the course.

(3) Dynamometers.

(4) A wattmeter registering the motive power at every point.

The platform at present in use can easily attain a speed of 33 metres a second.

As open-air experiments are not always desirable or possible, a whirling table has been installed in a circular building, 38 metres in diameter. The axis of the planes or propellers tested on the end of the arm will be 16 metres from the centre, thus describing a circle 100 metres in circumference. There are two motors one of 20 HP. which turns the arm, and another of 25—30 HP. which is connected up with any propeller undergoing tests.

There only remains to mention the Library, on behalf of which an appeal is made for gifts of books, pamphlets and prints, and the bulletin of the Institute in which will be published from time to time the results of the work accomplished.

T. O'B. H.

MEETING OF THE INTERNATIONAL COMMISSION FOR AERONAUTICAL MAPS

BRUSSELS, 26 AND 27 MAY, 1911

DELEGATES

GERMANY :	DOCTOR BERSON.	BELGIUM :	COMMANDANT MALEVÉ.
	VON FRANKENBERG.		ROBERT GOLDSCHMIDT.
	DOCTOR BAMLER.		COL. JEANNE.
	CAPT. WAGELER.		LIEUT. BARON DE BETHUNE.
ENGLAND :	MR. GRIFFITH BREWER.	FRANCE :	PROF. BERGET.
AUSTRIA :	COMMANDANT SCHEIMPFLUG.		BLONDEL LA ROUGERY.
	DOCTOR PEUCKER.		SIRVEN.

THE first meeting was opened by Prince Roland Bonaparte, and after the usual preliminaries Commandant Malevé read a report on the business to be undertaken. He said that owing to the rapid development of practical aviation the urgent question to be considered was not the elaboration of detailed maps but the finding of some means to enable aviators to go from one place to another without risk of losing their way. The pilot must not stray from his proper direction, or if he did must be able to regain it without hesitation. It did not appear indispensable for him to know precisely the place over which he passed. A near determination of direction would suffice. Existing maps and signs were inadequate.

What was wanted was something easily understood, cheap, and capable of enabling the locality to be quickly recognised not only during day and night, but also in fogs. The question of cost included not only the expense of installation and upkeep of signs, but also of any necessary alterations of existing maps. If the system were to be extended over large areas (Europe, for example) an international system should be aimed at.

When the system had been settled, an experimental period would be necessary to establish certain unknown factors, such as visibility, dimensions, &c. These experiments should be undertaken by the respective Aero Clubs, and a definite decision would depend on their report.

Professor Berget (France) moved that the work of the Commission be divided into two parts—maps and signs. This was agreed to. He then read a report of the permanent sub-committee-on-aerial-navigation of the Ministry of Public Works, France. The points brought out in this report were accepted as the basis of discussion.

Scale

During the discussion on this point, the question of having transparencies to place over ordinary maps was raised but did not find favour.

The following decision was finally arrived at :—

> " The adoption of a single scale is indispensable. The Commission proposes the scale 1 to 200,000 (about 4 miles to the inch), leaving it entirely to each country to make maps of different scales for its various special needs."

Division of Sheets

The Commission was held to be bound by the international geographical Commissions, and the following decision was agreed to :—

> " The map is to be divided on the sexagesimal system. Sheets will be cut from degree to degree following parallels and meridians. Centesimal graduations may be shown in the margin."

Notation

"The numbering of maps will be done on the supposition that the earth is divided into quadrilateral areas bounded by each 15° of longitude and 5° of latitude.

"A capital letter will be assigned to each division, the first, that limited in the West by the meridian of Greenwich, will receive the letter A. The numbering will be continued towards the east in alphabetical order, the letters I and O being omitted for practical reasons."

"A small letter will be used for each division of 5 degrees of latitude, starting from the equator, in alphabetical order, those to the north having the sign + and those to the south the sign —."

A sub-committee consisting of Messrs. Berget (France), Berson (Germany), De Bethune (Belgium), and Brewer (England), was entrusted with the consideration of further questions in regard to numbering, and its conclusion was adopted, as follows :—

"Each sheet belonging to a quadrilateral indicated by its two letters, will be defined, in that quadrilateral, by two numbers, the first running from 01 to 15 in the direction of increasing longitude, the figure 0 being placed before the first nine numbers, and the second running from 1 to 5 in the direction of increasing latitude."

Conventional Signs

The discussion showing that unanimity on this point was unlikely, the following decision was arrived at :—

"Generally speaking, complete liberty is allowed in the choice of conventional signs. The Commission simply puts forward the view that strings of red crosses should be used to denote overhead electric wires."

"Geographical names will be written in the language of the country to which they relate."

"Besides its distinguishing letters and figures each sheet will have at the top the name of the principal town therein. The names of adjacent sheets will be placed at the sides to facilitate joining-up."

It was also agreed that the map should be as free as possible from useless detail, that a scale of tints should be adopted for showing height of land, that the map would gain in clearness if the names of localities were left out, and that the intersections of the lines of equal magnetic inclination and of equal horizontal component should be shown to assist in location in fog.

Signals

A long discussion took place as to signals, much diversity of opinion existing. In the end the following guarded opinion was adopted :—

"The International Commission for Aëronautical Maps is of opinion that at the present time it is premature to choose any particular system of signals and thus to lead to considerable outlay.

"It thinks it prudent to await the practical results which the European Circuit of June, 1911, and the German Aviation Circuit cannot fail to furnish, as a series of signals will have to be established for these."

"With the aid of the results thus obtained and after having taken the advice of the aviators taking part in these trials, the Commission will be able to arrive at a conclusion with a knowledge of the matter at some subsequent meeting."

The Commission also said that the Governments who had undertaken the protection of the signals placed on the route of continental aviation circuits were thus allowing the carrying out of an experiment of the greatest utility from the point of view of aëronautical development.

The Commission desires every Aero Club affiliated to the F.A.I. to make an effort to produce, with the least possible delay, some sheets of the International Aeronautical Map.

B. G. C.

NOTES

Fatalities of 1911. At the moment of writing thirty fatal accidents have occurred this year, causing death to thirty pilots and four passengers. In every case, except one, where reliable news is available, the accident has been due to one of three causes, inexperience, recklessness or faulty construction of the machine. The exception was the sad case of Mr. B. G. Benson, who apparently died of heart failure while flying. Faulty construction is the most fertile source of accidents, and always will be until constructors put first-class engineering knowledge into their work. An aeroplane, to use a well-known advertising phrase, must be "built like a gun"; it must be the best work designed by competent engineers to ample factors of safety.

Several terrible accidents have been caused by the machine catching fire, which is an absolutely avoidable mishap. The petrol tank should so be placed in relation to the motor that should the piping break or become detached or the carburetter catch fire, no great harm can ensue. As our excellent contemporary, the *Scientific American*, pointed out recently, the petrol tank in a monoplane should be carried in the body behind the pilot, the fuel being forced to the carburetter under pressure. There should also be a shut-off under the pilot's hand. In a biplane the tank should be beneath the lower plane, or suspended between the outriggers well to the rear.

Date.	Name.	Nationality.	Machine.	Place.
Jan. 9 ..	E. Rusjan	Roumanian	Rusjan (1)	Belgrade
Feb. 6 ..	Lieut. W. Stein	German	Albatros (2)	Döberitz
Feb. 8 ..	J. Nöel H. de la Torre	French French	Sommer (2)	Douzy
Mar. 28 ..	J. Cei	Italian	Caudron (2)	Issy-les-Moulineaux
April 14 ..	Lieut. L. Byasson	French	M. Farman (2)	Coignières
April 18 ..	Capt. E. Tarron	French	M. Farman (2)	Villacoublay
April 20 ..	Louis Lière	French	Lière (1)	Châlons
April 22 ..	W. A. Purvis	American	Gates (2)	Baton Rouge (La.)
May 1 ..	Capt. Matzievitch Lieut. Matzievitch	Russian Russian	Blériot (1)	Sevastopol
May 6 ..	R. Vallon	French	Sommer (2)	Shanghai
May 10 ..	Lieut. G. Kelly	American	Curtiss (2)	San Antonio (Texas)
May 11 ..	H. Bockmüller	German	Poulain (1)	Johannistal
May 17 ..	A. V. Hartle	American	Curtiss-type (2)	Dominguez (Cal.)
May 18 ..	P. M. Bournique Lieut. P. Dupuis	French French	Déperdussin (1)	Bétheny
May 23 ..	C. Laemmlin	German	Farman (2)	Strasburg
May 25 ..	B. G. Benson	English	Valkyrie (1)	Hendon
May 27 ..	V. Smith	English	Sommer (2)	St. Petersburg
May 28 ..	Cirro Cirri	Italian	Blériot (1)	Voghera
June 3 ..	Queiroz	Brazilian	Blériot (1)	Sao Paulo (Brazil)
June 5 ..	M. Pennot	French	Curtiss-type (2)	Havana
June 6 ..	Lieut. E. Bague	French	Blériot (1)	Lost at sea, off Nice
June 8 ..	R. Marra	Italian	Marra (2)	Rome
June 11 ..	V. Wiesenbach	German	Wiesenbach (1)	Wiener Neustadt
June 9 ..	G. Schendel H. Voss	German German	Dorner (1)	Berlin
June 18 ..	Lieut. P. Princeteau	French	Blériot (1)	Issy-les-Moulineaux
June 18 ..	T. Lemartin	French	Blériot (1)	Issy-les-Moulineaux
June 18 ..	P. Landron	French	Pischoff (1)	Epieds
June 29 ..	Lieut. Truchon	French	Farman (2)	Mourmelon
July 14 ..	E. Paillole	French	Farman (2)	Algiers
July 14 ..	D. Kreamer	American	Curtiss-type (2)	Chicago

(1) Monoplane. (2) Biplane.

The Aëronautical Society of South Africa. A Society for South Africa has been recently formed under the presidency of the Hon. Johann Rissik, Administrator of the Province Transvaal with its headquarters at Pretoria. Its objects are set out in the rules as follows :—

> The Society is established for the purpose of giving a stronger impulse to the scientific study of aerial navigation. Its aims embrace theoretical and practical research into all phases of the problem, by any suitable means, such as laboratories, experimental grounds, and so forth; the promotion of intercourse between those interested in the subject in South Africa as well as in different parts of the British Empire and abroad; the aiding with advice, instruction and facilities those studying the subject; the organising of meetings, lectures, discussions, exhibitions; the issuing of publications, as well as the maintenance of a library of aeronautical works, &c., &c.

The rules are generally modelled on the old rules of the Aëronautical Society of Great Britain, but the Society states that its object is to be the paramount authority in South Africa on aeronautical science, sport and propaganda. Somewhat wisely it adds that its scientific duties "will be more limited than those of the British Society." Various Aero Clubs to be formed in South Africa are to be branches of the Society, while under their own independent management, and they are to have representatives on the Society's Council.

In such a courageous and ambitious scheme the new Society has our best wishes for success. Time alone can prove whether the proposed arrangement is workable. We would add congratulations to Major A. M. Rogers and Mr. A. G. Heinze, both members of our Society, to whom the formation of the South African body is in great measure due.

Alexander Motor Competition. The entries for the prize of £1,000 offered by Mr. Patrick Y. Alexander for Aerial Motors are seven in number: W. L. Adams (Bournemouth); the Aero-Flight Engine Co.; the E.N.V. Motor Syndicate Ltd.; the Green Engine Co.; the Isaacson Radial Engine Co. Ltd. (Leeds); the New Engine Motor Co. Ltd.; and the Requa Motor Company (New York). The competition is open to motors from 40 to 75 HP, which will be tested on two continuous runs of 12 hours each, together with such additional tests as may be necessary for the purposes of the Competition. The main points considered in the comparison of motors will be (1) the gross weight per measured B.HP.; (2) reliability and steadiness of running; (3) wear of working parts.

The engines are to be tested at the Army Aircraft Factory, South Farnborough, under the direction of the engineers of the National Physical Laboratory.

The Government Advisory Committee will report on the results, and the award will be made by a Joint Committee of the Aëronautical Society, the Royal Aero Club and the Aerial League, in conjunction with Mr. Alexander.

The Era of the Aeroplane Circuit. As was inevitable in accordance with the certain trend of events, the aviation meeting of yesterday has to-day grown into the aeroplane circuit. This development was not only inevitable but, strange to say, had long been surely foreseen. One need only recall the late Captain Ferber's epigrammatic sentence: "de crête à crête, de ville à ville, de continent à continent," uttered some three years ago now, to summarise the progress of aviation to-day and the lines of its development to-morrow. The first long-distance race took place in May and extended from Paris to Madrid, a course that in its latter part is probably unequalled elsewhere in Europe for sheer difficulty. Védrines, the Morane pilot, who has suddenly leaped into prominence, was the only one to accomplish the journey—and that within the space of three days. Within a week followed the race from Paris to Rome, via Lyon, Nice and Genoa, eventually won by "Beaumont," the pseudonym assumed by the French Naval lieutenant Conneau, on a Blériot monoplane. Three other competitors, Garros, Frey and Vidart completed the distance, but only Frey was venturesome enough to attempt to tackle the last portion of the race, where the course lay over the Apennines, via Florence to Turin. Unfortunately he made a bad landing not far from Rome and was seriously injured. The first real circuit—in that the course was a circular one with return to the starting point—has been the so-called "European" contest jointly organised by a French and an English newspaper. This was the first contest that may be termed a "reliability" contest, since it included certain definite stages to be flown on predetermined dates. Beaumont, who, curiously enough, failed to win a single one of the stages, accomplished the best average performance, and flew the entire course of just on 1,000 miles—from Paris to Liège, Utrecht, Brussels, Calais, London, and thence via Calais again to Paris—in 24½ hours' flying time, which gives the high average speed of just 40 miles an hour. Of the forty starters, no less than seven accomplished the entire journey, which included the passage of the Ardennes, and two crossings of the Channel. Simultaneously, the north German Circuit—an offshoot of the "European" contest, but designed especially for the encouragement of the German pilot and industry—was run from Berlin. By reason of the various halts, including one of an entire week at Kiel, the German contest extended to nearly one month, and was distinguished by the fact that the first three competitors to complete the circuit were of German

nationality, flying German-built machines, and that each carried a passenger throughout the contest. The Circuit of Great Britain organised by the *Daily Mail*, and dowered with a single prize of £10,000, completes the list save for the more modest Belgian National Circuit—which is a " tourist " race in the true sense of the word—to be flown in the first fortnight of August.

The Circuit of Britain was a great success. The course lay from Brooklands via Hendon, Harrogate, Newcastle, Edinburgh, Stirling, Glasgow, Carlisle, Manchester, Bristol, Exeter, Salisbury Plain, Brighton, back to Brooklands, a distance of approximately 1010 miles. Lieutenant Conneau, flying under the name of " Beaumont," completed the course on a Blériot monoplane in 22 hours, 29 min. 6 sec. of actual flying time ; and Védrines was second on a Morane-Borel monoplane in the time of 23 hours 38 min. 5 sec. Both competitors used Gnome motors, and had not Védrines missed his way to the alighting ground at Bristol, the result would have been very nearly a dead heat.

The showman of course plays no insignificant part in these circuits, as they are promoted from commercial motives rather than from the lofty ideal to benefit the science and aid the progress of aerial navigation. And to some extent it is undoubtedly true that aviation is being exploited. Nevertheless, there is no doubt but that the circuit, in its brief career, already has reacted beneficially on the development of aeronautics, and that benefit will surely be felt within the next few months. British aeronautics, at any rate, will owe a permanent debt to the *Daily Mail* Circuit.

NEW BOOKS AND PUBLICATIONS

*First Report of the Bird Construction Committee. Compiled by Col. J. D. Fullerton (late R.E.) (London : Aeronautical Society of Great Britain. 1911. Royal 8vo. oblong. pp. 61. Illus. 10s. 6d. n.)

*The Conquest of the Air. Alphonse Berget. London : Heinemann. 1911. (New and Revised Edition.) pp. 249. Illus. 6s. n.

*Aerial Locomotion. E. H. Harper, M.A., and A. Ferguson, B.Sc. With an introduction by G. H. Bryan, Sc.D. Cambridge : University Press. 1911. pp. 164. Illus. 1s. n.

*Monoplanes and Biplanes : their Design, Construction and Operation. G. C. Loening, B.Sc. New York : Munn & Co. 1911. pp. 331. Illus. $2.50 n.

*Passé et Avenir de la Navigation Aérienne. Capitaine du Génie E. Caslant. Paris : R. Chapelot 1911. pp. 369. Illus. 5 francs.

Les Ascensions en Cerfs-Volants. G. Houard. Paris : Librairie Aéronautique. 1911. pp. 110. 2 francs.

Smithsonian Publications : What Constitutes Superiority in an Airship. Commandant Paul Renard. pp. 141—155 ; The Upper Air. E. Gold and W. A. Harwood. pp. 261—269 ; *The Flying Apparatus of the Blow-fly. Dr. Wolfgang Ritter. pp. 76. Illus. ; Smithsonian Physical Tables. pp. 318. Washington : Smithsonian Institute.

*Weather Science : An Elementary Introduction to Meteorology. F. W. Henkel, B.A. London : T. Fisher Unwin, 1911. pp. 336. Illus. 6s. n.

*Essai D'Aérodynamique du Plan. Armand de Gramont, Duc de Guiche. Paris : Hachette. 1911. pp. 211. Illus.

*How Men Fly. Gertrude Bacon. London : Cassell, 1911. pp. 117. Illus. 1s. n.

* Notice of this book will be found in the present issue.

REVIEWS

The Conquest of the Air. By Alphonse Berget. (London: Heinemann, 1911. New and Revised Edition. pp. 249. 6s. net.)

A CHEAPER edition of Professor Berget's excellent work is very welcome. In our review of the first edition (AËRONAUTICAL JOURNAL, October, 1909) we were obliged to take exception to the translation, and again we have to regret that the translation does its best to conceal the brilliancy of the original. The terrible expression "aviation apparatuses" still remains, and all the errors that we noted previously. On page 212 the aeronautical "Mrs. Harris," Dr. Walden, once again suffers a paper death at Minneola; Hargrave appears as "Hargreaves"; and on pages 98 and 99 the terms "soaring flight" and "sail flight" are used, when the first should be "gliding flight" and the second "soaring flight"—an inaccuracy of considerable importance. At the end of the book the first report of the Aëronautical Society's Technical Words Committee is reprinted by permission, but the heading given to it—"Glossary of French Aeronautical Words Anglicised by the Technical Words Committee"—is quite erroneous, since the report was entirely original and creative. The book is well-got up and well illustrated, and in spite of the translation may be thoroughly recommended as a popular history and explanation of aerial navigation.

Passé et Avenir de la Navigation Aérienne. By Capitaine du Génie E. Caslant. (Paris: Chapelot, 1911. pp. 369. Illus. 5 francs.)

MM. CHAPELOT'S imprint is a guarantee of excellence—at any rate as far as aeronautical literature is concerned. Their latest issue by Captain Caslant is well up to the mark. It is an exhaustive a book as any that have yet come under our notice, and deals with the following headings: The Technical and Social Aspect of Aerial Navigation, The Laws of the Atmosphere, Aerostation Past, Present and Future, Aviation Past, Present and Future; The Social Side of Aerial Navigation. There is also an instructive chapter on "Les Mixtes" or aerial hybrids.

Prophecies are always interesting, and Captain Caslant gives cause for thought. The future of aerostation, he says, is the survival of the spherical, and here we agree with him. In aviation he looks forward to the "helicoplane," a machine with variable surfaces and movable wings with eight screws or more, if necessary, operating in various directions at will. The power is supplied by a species of turbine. He puts in also a word for the ornithoplane, which is to increase but not to multiply. Speeds for flying are fixed at 300—400 kilometres per hour. "Les mixtes, dérivant de l'aéroplane à grand rendement dynamique et représentant le progrés ultime de la navigation aérienne"—they are the future. The book is well worth reading.

Aerial Locomotion. By E. H. Harper, M.A. and Allan Ferguson, B.Sc. With an Introduction by G. H. Bryan, Sc.D. (Cambridge: University Press, 1911. pp. 164. Illus. 1s. net.)

A DIFFICULTY arises in deciding what public will be attracted by this little book, which deals with general principles, motors and propellers, stability and control of aeroplanes, model aeroplanes and gliders, aeroplanes and dirigibles, finishing with a brief chapter on history. The matter is dealt with in a competent but somewhat unattractive manner. We venture to fear that the book placed in the hands of a boy or even an adult enquirer after aeronautical knowledge would discourage further study. Elementary truths must be made as interesting and as simple as possible. The style and arrangement of "Aerial Locomotion" leave much to be desired, though of its accuracy there can be no question. With reference to p. 146 it may be mentioned that the breaking of the tail, and not a rib of his glider, as there stated, caused Pilcher's death.

The Flying Apparatus of the Blow-Fly. By Dr. Wolfgang Ritter. (Washington: Smithsonian Institution, 1911. pp. 76. Illus.)

THIS important work appears at an opportune moment. Firstly, it is a valuable addition to the library of the student of natural flight, and secondly it affords an excellent example of how scientific research can be extended by judicious money grants to competent experimenters. The Smithsonian Institution is distinctly to be felicitated on the result of its grant to Dr. Wolfgang Ritter, whose researches in the Zoological Laboratory of the German University at Prague are the basis of this book.

So comprehensive a representation of the entire mechanism of flight of an insect had not previously existed, nor had photography been employed, owing to the many technical difficulties to be met. Dr. Ritter has successfully overcome these, and the stereoscopic photomicrographs of the skeleton, muscles and wings are a monument to his painstaking skill. By their means, combined with the detailed notes, the student is enabled to grasp the complicated structure of the blow-fly more easily than if it were as large as a sparrow and were dissected before his eyes.

After an interesting introduction Dr. Ritter proceeds to a short historical survey of the subject, before giving a description of his methods of preparing specimens for examination and illustration. A general description of the thoracic skeleton, the wing, and the muscles, comes next,

followed by a study of the movements of the wing and of the functions of the muscles and joints. A synopsis of results ends this portion of the book. A very good bibliography is given, which, however, makes no mention of Mr. Senecal's work (1870, 5th Annual Report of this Society), or of M. Lucien Bull's beautiful kinematographic studies of insects in flight. The latter portion of the book consists of the photomicrographs previously mentioned, with explanatory diagrams and notes, some tracings of the wing path, and a plate of von Lendenfeld's photographs of the blow-fly in flight.

The value of books of this nature, from the standpoint of aviation, is often vitiated by the fact that the author has apparently not made a study of flight or propulsion as a mechanical problem apart from its application in the insect he is studying. This criticism may be applied to the present work, the description of the action of the wing during flight (page 30) being inadequate and in parts decidedly misleading. The statement that during the upstroke the wings act as gliders is, for instance, contrary to the function they would have if the wing be regarded as an oscillating-propeller (which it undoubtedly is) and is directly contradicted by examination of von Lendenfeld's pictures on page 77.

Moreover, immediately below the above statement appears the following:—"During the backward movement above mentioned the wing opposes . . . resistance to the air . . . enough to produce the necessary forward impulse." We are thus asked to conceive the wing as being at one and the same time a propeller and a glider, *i.e.*, producing negative and positive pressure on the same face simultaneously.

Again we have (page 34): "The downstroke produces an elevation of the insect's body which overcomes gravity but retards the forward movement," whereas on page 29 appears the statement that during the downstroke the wing (in ordinary forward flight) is nearly horizontal, but "the unsupported anal portion of the wing remains somewhat behind." This would make the wing have a slight backward and upward angle with the horizontal, giving a forward impulse.

All difficulties in the interpretation of the wing action disappear if we conceive it as being simply that of an oscillating-propeller of which the plane of oscillation is altered according to the amount of forward thrust required. This theory accords perfectly with the photographs available, von Lendenfeld's and Bull's showing it quite clearly.

Dr. Ritter is of the opinion that the hair with which the wing is covered helps to "increase the working pressure during the downstroke." This savours rather of the school of thought which conceives flight to be bound up in the problem of "getting a good grip of the air." Is it quite definitely decided that these hairs have no sensory function, or are not simply a means of preventing adherence of moisture and dust to the actual wing membrane?

The curves which Marey obtained by causing the fly's wing to rub against a moving blackened surface were incomplete and Dr. Ritter has obtained some better ones by an improved instrument which he calls a "flight-kymograph." These show the well-known figure-eight curve very well indeed. It is strange, however, that Dr. Ritter was not aware of the beautiful instrument which Mr. Senecal exhibited before this Society in 1870, and which was in some respects superior to Dr. Ritter's.

On page 29 appears the statement that whereas the movement of the wing while describing the lower curve of the eight is a forward one, the upper curve is described by a backward movement. This is incomprehensible. No figure-eight curve such as is shown in the plates could be produced by a combination of such movements.

It is a pity that von Lendenfeld's pictures of the fly in flight should have been produced without amendment of the misleading position occupied by the two views of each phase in relation to each other. Two lines of pictures are placed one immediately above the other. One shows an end view and the other a plan view of the insect, but the end view is not placed above the plan view and the lines "run" in opposite directions. They should have been quite separated.

Apart from these faults the book marks a great advance in the study of insect flight.

B. G. C.

First Report of the Bird Construction Committee. Compiled by Colonel J. D. Fullerton (late R.E.) (London: Aeronautical Society, 1911. Royal Oblong 4to. pp. 61. Illus. 10s. 6d. net.)

THE Bird Construction Committee's Report is not only a monument to the tremendous industry of the compiler, Colonel Fullerton, but the only complete introduction to the study of bird-flight from the aeronautical point of view yet published. The introductory remarks are divided into four sections: the Classification of Birds, a General Description of Flight and Flight Manœuvres, the Physical Characteristics of Birds, and Observations and Calculations regarding the Velocity of Birds, Power expended, &c. The tables include (1) the General Ornithological Classification of Birds; (2) Aeronautical Classification; (3) the Physical Characteristics of Birds; (4) an Index to (3), and (5) Velocities of certain Birds. Table 3 contains 459 entries, giving the name of each bird in scientific terms and in six languages, its weight, surface, span, weights of muscles, wing beats, &c. The printing, arrangement, and illustrations are excellent, and the book is a contribution of the greatest value to aeronautical science.

How Men Fly. By Gertrude Bacon. (London: Cassell, 1911. pp. 117. Illus. 1s. net.)

WHEN Miss Bacon writes, we are all willing to read. Her clear, humorous style would charm the dourest. "How Men Fly" will be delightful to everybody who pretends to any interest in aviation, while those who do not will be speedily converted if they but dip into its fascinating pages. While frankly claiming to be a purely popular book, it subtly manages to convey a great deal of technical information for the education of the unsophisticated reader. From the ferocious-looking pilot, preparing to glide, on the cover, to the index at the end, all is charming and commendable.

Essai d'Aerodynamique du Plan. By A. de Gramont, Duc de Guiche. (Paris: Hachette, 1911. pp. 211. Illus.)

THIS book describes very clearly the results of the various experiments made by the author to ascertain the pressures, centres of pressure, &c., on plane surfaces of different shapes. It is evident that the work has been very carefully carried out, and it is to be hoped that the author will extend his experiments to curved surfaces and bodies, as information of this kind is very much required.

In Chapter I. a description of the apparatus employed, and the method of working it is given. Briefly, the surfaces to be tested were mounted on a motor car, special arrangements being made to ensure their being accurately fixed at the required angles of attack. The car was run along a concrete-laid road, great care being taken to make the runs when the air was at rest. A hut containing suitable apparatus was erected at the side of the track, and all the movements, viz., velocity pressure variations, &c., were automatically recorded by suitable instruments. The general arrangements, especially the photographic records, of the columns of fluid showing the pressures, were very ingenious, and owing to the automatic methods of recording the results obtained, appear to be exceptionally efficient.

Different-sized surfaces were used, and from the pressures obtained, the total pressures, centres of pressure, &c., were calculated. The main object of the author was, however, to ascertain the *distribution* of the pressures as this is a point to which experimenters, as a rule, have paid very little attention, and most elaborate work was done in this direction. In Chapter II. the results of the experiments for finding the pressures on the anterior faces of the surfaces is given, while similar results for the pressures on the posterior faces are described in Chapter III.

In Chapter IV. the total resultant pressures, &c., are discussed and conclusions drawn from the results obtained. The total pressures seem to agree fairly well with the values obtained by Eiffel, but on the whole they appear to accord best with the formula of Duchemin and Soreau. The centre of pressure results were almost exactly the same as those obtained by Soreau.

The book is splendidly illustrated, the pressure diagrams being exceptionally good. It is to be hoped that the author will continue his experiments, as the novel lines upon which they are conducted form a useful method of check on the results obtained by other workers.

J. D. F.

Weather Science: An Elementary Introduction to Meteorology. By F. W. Henkel, B.A. (London: Fisher Unwin, 1911. pp. 336, Illus. 6s. n.)

THIS book discusses various matters connected with the weather in a somewhat discursive style, and a description of the more common meteorological instruments is given. The book is disappointing, and some of the statements made in it unreliable. The science of meteorology has made such rapid progress in recent years that great care is required in repeating statements extracted from textbooks of thirty or forty years' standing, and such care has not been exercised. Thus the effect of the Gulf Stream on the climate of England figures very prominently in the book, notwithstanding the fact that the stream flows much nearer to New York where the winter is cold, than to London where it is mild. This is on the supposition that the Gulf Stream does reach the British Isles, but if anyone will take the trouble to study the Pilot Charts of the North Atlantic published monthly by the Meteorological Office, he will see the Gulf Stream shown plainly enough along the American Coast, where be it noted the temperature of the stream is high but the winters are very cold, but he will require an extremely good imagination to discover any stream at all near the British Isles. There are many similar blemishes: the isothermal layer is said to have been discovered by means of kites, but is of course far beyond the range of height of any kite. The author deserves credit for his remarks on many popular fallacies, the influence of the moon on the weather for example. The book is well printed and fairly free from misprints and small errors.

W. H. D.

Monoplanes and Biplanes: Their Design, Construction, and Operation. The Application of Aerodynamic Theory with a complete Description and Comparison of the Notable Types. By Grover Cleveland Loening, B.Sc. A.M. (New York: Munn; London: Sampson Low, 1911. pp. 340, Illus. 12s. 6d. n.)

THE groundwork of this book seems to have been a thesis written by the author under the direction of Dr. Charles C. Trowbridge, of the Department of Physics, and in fulfilment of the requirements for the M.A. degree of Columbia University.

One concludes from the Preface that he has made it his aim to attempt to fill up the gap between the book produced merely to please the popular palate, and the more highly technical and mathematical treatises who too often are caviare to the general.

It may be said that the author has succeeded in avoiding the obvious error of falling between two stools, and has certainly presented his subject in a practical manner at once intelligible to the average man as well as of value to the aeronautical student.

Chapter I. deals historically, and in an interesting way, with the researches of the earlier pioneers, and as might be expected from an American author, the valuable work of Langley receives the recognition which is its due.

Chapters II. to VII. are devoted to air-resistance, pressure on flat and curved planes, and analogous subjects.

In Chapter VIII. is given a numerical example of useful calculations for the design of an aeroplane, and here Mr. Loening very rightly insists that any super-refined calculation to hundredths or even tenths of a lb. for lift and drift ratios has no real *raison d'être*; 5 to 10 lbs. for lift, and 1 or 2 lbs. for drift, being quite exact enough limits for ordinary work. In his specification for a biplane with 350 sq. ft. area, 1000 lbs. weight, and 45 m.p.h. air-speed, the $\frac{1}{12}$ main surface camber seems to be of an excessive order, and an assumed propeller efficiency of 75 to 80 per cent. also errs in the same direction. More or less prominent types of machines are fully described in Chapters X. and XI., including eighteen Monoplanes and twenty Biplanes.

On p. 205 referring to the Goupy biplane, the staggering of the main surface in this design is explained as giving increased stability in "volplaning." It might also be added that the lower plane being placed slightly aft of the upper planes causes less interference between the surfaces, as proved by Seller's experiments in America, though owing to the struts raking forward, this disposition is not so good as regards strength.

In Chapter XII. different types are compared, and there are some very clear diagrams of control arrangements in Chapter XIII. The remaining chapters deal with accidents and improvements.

The work is fully illustrated, and commendably free from misprints, while the many references given are likely to be of use; the drawings and diagrams, though small, have the merit of all being reproduced to the same scale, which greatly facilitates comparison.

It is, however, to be regretted that so many "faked" photographs should have been included; though possibly attractive to the public, their insertion cannot be too strongly deprecated in any work with pretensions to scientific value.

H. F. L.

"La Resistance de l'Air et L'Aviation." Par. G. Eiffel. (Paris: Dunod and Pinat, 1910. pp. 156. Illus. 18 francs.)

THE report of M. Eiffel's latest researches is a model of thoroughness and careful experimenting, and forms a most valuable addition to the data which has already been given in his previous works.

The wind tunnel in which the experiments were carried out and the measuring apparatus used have been fully described in the paper M. Eiffel read in January, 1910, before the Society of Civil Engineers of France. The long delays, caused by waiting for calm weather, made impossible the continued use of the "Chute" method which was used in the former experiments. Its abandonment, however, in favour of the wind tunnel did not end the difficulties in the way of the experimenter. To allow of the use of large planes without getting "end effects" due to the presence of the tunnel walls, the experimental chamber was increased in size, allowing the live air stream to flow through the still air of the experimental room. It is in this arrangement that errors are likely to arise, throwing a shadow of doubt on the accuracy of the results. Some interesting stream-line smoke photos showing the distribution of the air current in a model of this tunnel were published by Riabouchinski a short while ago in the *Aérophile*. The air stream on emerging from the tunnel entry into the experimental room broadens out as might be anticipated, contracting again to the original cross section at the intake tunnel of the fan.

The stream-lines are thus by no means parallel, and, if the planes under test were close up to the tunnel from which the air flows into the room, the diverging effect of the air would tend to reduce the "lift" on the plane, causing the lift on a plane of fairly high aspect to be no better than one of smaller aspect ratio with a parallel stream-line distribution.

When the results of these experiments are compared with previous data, the discrepancy is just along these lines. For the "lift" on a flat plane M. Eiffel has found a similar "aspect ratio" effect to that given by the writer in the last number of the AËRONAUTICAL JOURNAL, a straight line law being a very near approximation to the relation between "sweep factor" and "aspect ratio" in the limits used in aeronautical work. The formula given reduces to

$$\text{Sweep factor} = (1{\cdot}18 + {\cdot}185n)$$

where n is the aspect ratio of the plane. The writer's formula reads :—

$$\text{Sweep factor} = ({\cdot}85 + {\cdot}35n)$$

Whilst agreement is obtained between the two results at low values of the aspect ratio the divergence increases as the aspect ratio becomes greater. Further experiments are necessary with a different type of tunnel so as to compare the present results and see if the low values of "sweep factor" obtained by Eiffel are due to the tunnel shape. It is interesting to note that both the experiments carried out at Gottingen and also by Finzi and Soldati agree better with the higher values.

The balancing of a plane at 35° with one at 90° described on page 46 is a most interesting demonstration of the "hump" in the pressure curve, the pressure on the plane being greatest at an angle a good deal less than 90°. This can, however, be only a qualitative experiment, owing to the influence of the one plate upon the other, the effect noticed in some of Dines' experiments.

The plane tests are followed by a most comprehensive research with curved surfaces, sections being chosen of the exact outline of several well-known aeroplanes such as the Wright, Voisin, Farman, Blériot, Bréguet, Nieuport, Esnault Pelterie, in addition to planes of varying curvature both monoplane and biplane. Details are given in every case of the exact curvature of the section, the travel of the Centre of Pressure, the total resultant pressure, the "lift," the "drift," and the pressure distribution at certain angles.

In general these results are as noticed with the flat planes smaller in value than those obtained by other experimenters. The angle at which the lift becomes zero is about $-3°$ to $-4°$ the pressure following practically a straight line law from this point up to 6° to 10° depending upon the curvature.

The most interesting part of these results are the pressure distribution curves showing the actual pressure values obtaining at different points on the plane section from front to back. The Blériot, Bréguet, and Nieuport planes have according to these results sections which meet the air and allow it to leave with very little disturbance, and these again have the best "lift" to "drift" ratios. Here, too, one has a picture of the influence of one plane of a biplane has upon the other.

In addition to the curves, the figures are tabulated out for all the experiments so that an analysis of the results is easy, and more accurate than reading off the figures from small scale curves. The general arrangement of the book is excellent, and the systematic and comprehensive way in which the tests are dealt with will without doubt make the work a "classic" in aeronautical science.

F. H. P.

ANALYSIS OF FOREIGN PUBLICATIONS

ABBREVIATIONS

Aeron., Aeronautics (New York).
Aerop., L'Aérophile (Paris).
Die Luft., Die Luftflotte (Berlin).
Aer., L'Aéronaute (Paris).
D.Z.L., Deutsche Zeitschrift für Luftschiffahrt (Berlin).
O.F.Z., Osterreichische Flug-Zeitschrift (Vienna).
Rev. Aer., Revue Aérienne (Paris).
Rev. de l'Av., Revue de l'Aviation (Paris).
Tech. Aer., Technique Aéronautique (Paris)

ACCIDENTS
Enquête sur les Accidents d'Aéroplane. (Bouttieaux.) *Aérop.* May 15.

AERODYNAMICS
Note sur la résistance de l'air. (Chovet.) *Rev. de l'Av.* April 1.
Ailes planes et ailes arquées. (Ernoult.) *Rev. Aer.* April 25.
Etudes d'aérodynamique du laboratoire des aérostiers militaire italiens. (Crocco.) *Tech. Aér.* May 15 and June 1.
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A. Kimmerling. *Aérop.* May 15.
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La nécessité d'appliquer un embrayage aux aéroplanes. (Monniot.) *Aérop.* May 15.

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Multipoint ignition in internal combustion engines. (Heins.) *Aeron.* May.
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The testing of aeroplane engines. *Aeron.* July.

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Orientation in the air. *O.F.Z.* April 25.

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Design of propellers and planes. (Jarolimek.) *O.F.Z.* July 10.

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Closing circle aeroplane records. (Scragg). *Aeron.* May.

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Underground sheds for dirigibles. *Die Luft.* June.
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La stabilité des aéroplanes. (Voyer.) *Tech. Aér.* June 1.
Un nouveau système d'équilibre automatique. (Galvao.) *Tech Aér.* July 1.
Automatic stability. *O.F.Z.* May 25.

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